Remarks/Arguments

Claims 1-23 remain in the application. Claims 4, 19, 20 and 23 have been amended.

Drawings

The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the pluality of doped quantum well layers and contact layers must be shown or the feature(s) canceled from the claim(s). No new matter should be added.

Applicant has submitted a new drawing – Figure 1 – illustrating a multiple quantum well structure. Furthermore, applicant has amended the paragraph starting at line 4 on page 7 of the specification to include reference numerals used in newly added Figure 1. As is evident, newly added Figure 1 shows only features described in the original paragraph starting at line 4 on page 7. Therefore, no new subject matter has been added.

Furthermore, Applicant has amended the specification adding a brief description of Figure 1 and renumbering the figures.

The drawings are also objected to because:

(a) in Fig. 2, it is unclear what well doping concentration corresponds with which curve;

(b) in Fig. 3, units are lacking;

(c) in Fig. 3, "Responsivitys" should probably be --Responsivity --; and

(d) in Fig. 3, it is unclear what the plurality of curves without legend labels represent (it should also be noted that the curve legend "90" is not explained).

With respect to point (a) Figure 3 – formerly Figure 2 - has been amended to clearly indicate the well doping concentration of each curve.

With respect to point (b) Figure 4 – formerly Figure 3 - has been amended to comprise one figure for each diagram, i.e. Figures 4a-4c, each diagram comprising proper units.

With respect to point (c) Figures 4a-4c – formerly Figure 3 - have been amended according to Examiner's suggestion.

With respect to point (d), Applicant respectfully submits that each curve in Figures 4a-4c is indicated by a respective legend label, each legend label indicating a different temperature in degree Kelvin (K) as shown in the insert of each diagram. Furthermore, Applicant respectfully submits that the inserts clearly indicate each legend label and the corresponding temperature in K. The unit symbol K has been used only at the bottom of each insert for simplicity – indicating K for each of the numbers in the respective insert - and is frequently used in the art. Therefore, it is evident for one of skill in the art that the legend label with the respective number 90 – cited by the Examiner – indicates the curve for a Responsitivity at the temperature of 90 K.

The amended drawings are submitted herewith for the examiner's approval. Formal drawings will be prepared and submitted hereafter.

Specification

Applicant is reminded of the proper language and format for an abstract of the disclosure.

Applicant has submitted a new abstract herewith in order to overcome Examiner's objections. The new abstract recites the limitations of claim 1 and, therefore, does not add new subject matter.

Applicant has added a new paragraph in the specification on page 8 line 26. The newly added paragraph recites the wording of the limitation of claim 22 and, therefore, does not add new subject matter.

Claim Objections

The numbering of claims is not in accordance with 37 CFR 1.75.

Misnumbered claims 20 and 21 have been renumbered as 22 and 23, respectively.

Applicant will refer to the renumbered claims in the following response.

Claims 4, 19, 20 and 23 are objected to because of the following informalities:

(a) in claim 4, "dopant concentration" on lines 1-2 should probably be --doping density -- (see "doping density" in claim 5);

(b) in claim 19, "GigaHz" on line 2 should probably be --GHz--;

(c) in claim 20, "GigaHz" on line 3 should probably be --GHz--; and,

(d) in claim 23, "temperature" on line 2 should probably be --temperature.--

Applicant has amended claims 4, 19, 20 and 23 according to Examiner's suggestions.

Claims 22 and 23 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim.

Claims 22 and 23 are directed to a method whereas claim 19 is directed to a photodetector (it is suggested that "claim 19" should probably be --claim 21--).

Applicant has amended claims 22 and 23 according to Examiner's suggestions.

As is evident, the amendments do not add new subject matter.

Claim Rejections 35 USC § 112

Claim 22 is rejected under 35 U.S.C. 112, first paragraph.

Claim 22 recites the limitation "filtering the dark current component" which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Applicant has amended the specification at page 8, line 26 to include the step of filtering the dark current component as defined in claim 22. Therefore, the amendment does not add new subject matter. Filtering the dark current component is a well-known technique and is taught, for example, in Choi (US Patent 5,384,469), as cited by the examiner below. Applicant respectfully submits that claim 22 is now in compliance with 35 U.S.C. 112, first paragraph.

Claims 1-20 are rejected under 35 U.S.C. 112, second paragraph.

The term "low" in claims 1, 8, 9, and 10 is a relative term which renders the claims indefinite. The term "low" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Thus the limitation other than low temperatures is vague and indefinite and fails to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Applicant respectfully submits that the term "low temperature" is clearly described in the specification discussing the prior art. For example, on page 4 lines 14 and 15 Applicant discusses very low temperatures (<150 K), and on page 4 line 19 applicant discusses low temperature environments – typically cryogenically cooled environments. Furthermore, it is well established in the art for the term "low temperature" indicates a temperature <150 K.

The term "high" in claims 1, 2, 4, 8, and 9 is a relative term which renders the claims indefinite. The term "high" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Thus the limitation high absorption is vague and indefinite and fails to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Applicant respectfully submits that the term "high absorption" is clearly described in the specification. For example, on page 7 lines 4 and 5 Applicant teaches that a primary design goal is to achieve high absorption, and on the same page lines 19 and 20 Applicant

teaches that a d sired 90% QWIP absorption. Furthermore, it is also well established in the art for the term "high absorption" meaning absorption quantum efficiency greater than 50%.

The term "near" in claims 2 and 10 is a relative term which renders the claims indefinite. The term "near" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Thus the limitation near room temperatures is vague and indefinite and fails to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Applicant respectfully submits that the term "near room temperature" is clearly described in the specification. For example, on page 6 line 17 Applicant teaches that the device described in the specification can be used in near room temperature and within electronically cooled systems, and on page 8 lines 9 and 10 Applicant teaches that the device operates up to room temperature. It is well known in the art that room temperature is approximately 300K and it is well understood in the art that near room temperature is assumed to be in the range between 200K and 300K. Further, electronically cooled systems operate in the same temperature range.

The term "large" in claim 4 is a relative term which renders the claim indefinite. The term "large" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Thus the limitation dopant concentration is selected to be sufficiently large for high absorption during near room temperature operation is vague and indefinite and fails to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Applicant respectfully submits that the limitation "dopant concentration is selected to be sufficiently large for high absorption during near room temperature operation" is clearly described in the specification. For example, on page 8 lines 6 to 8 Applicant teaches that it is to be expected that the doping range of 1-2E12 cm^{-2} is where QWIPS operate near room temperature, and further at lines 13 and 14 on the same page Applicant

teaches that a 100-well QWIP with 1.5E12 cm^{-2} doping per well achieved high absorption and operated at and near room temperature. From this disclosure, it is evident to one of skill in the art how to determine such a dopant concentration without resort to further invention. Therefore, the limitation cited by the examiner particularly points out and distinctly claims the subject matter Applicant regards as the invention.

The term "substantial" in claim 9 is a relative term which renders the claim indefinite. The term "substantial" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Thus the limitation substantial dark current is vague and indefinite and fails to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

All prior art teachings address dark current as a problem in QWIP devices and attempt to reduce the dark current in order to achieve a high signal to noise ratio. However, Applicant has found that for certain applications a high dark current is tolerable, and a high absorption and high operating temperature is desirable, as taught on page 6 lines 18-25. The determination of the amount of dark current for various operating temperatures of QWIP devices is well known in the art. Furthermore, it is well known in the art that QWIP devices produce high dark current at near room temperatures. Therefore, Applicant respectfully submits that one of ordinary skill in the art is reasonably apprised of the scope of the invention – substantial dark current - by Applicant's teachings that the QWIP device according to the invention is operated at temperatures up to room temperatures.

Claim Rejections 35 USC § 102

Claims 1-3, 8, 21, and 23 are rejected under 35 U.S.C. 102(b) as being anticipated by Delacourt et al. (US Patent 5,160,991).

Referring to independent apparatus claims 1 and 8, Applicant discloses and claims a quantum well infrared photodetector comprising the limitation of a multi-quantum well structure for providing **high absorption at temperatures other than low temperatures**.

With respect to the teaching by Delacourt et al. in column 4 lines 40-44 ", as cited by the examiner, Delacourt et al. teach that for a QWIP to operate at room temperature the potential barrier should to be greater than kT=26meV. This teaching by Delacourt et al. is wrong. Assuming this teaching to be correct, it would be possible to operate most QWIPs at high temperature, since most QWIPs meet the above limitation specified by Delacourt et al. for high temperature operation. As is evident to one of skill in the art, this is not the case.

Applicant now found that for high temperature operation high absorption is needed - higher than the absorption specified at the low end of absorption ranges taught in the prior art. Paragraph 2131.03 MPEP states: "If the claims are directed to a narrow range, the reference teaches a broad range, and there is evidence of unexpected results within the claimed narrow range, depending on the other facts of the case, it may be reasonable to conclude that the narrow range is not disclosed with ''sufficient specificity' to constitute an anticipation of the claims". Therefore, it is novel to specify a new limitation which defines a range falling within a prior art range, i.e. high absorption for obtaining the unexpected result of a QWIP operating at high temperature. Other than the one incorrect teaching by Delacourt et al. the prior art teaches that low temperature is necessary for QWIP operation, i.e. the prior art teaches away from the invention.

Delacourt et al. as noted above are incorrect in their teaching. An erroneous teaching cannot properly anticipate claims to an invention which is properly taught. Using the Delacourt reference it would not have been obvious to one of skill in the art to make the present invention and as such it can hardly be anticipated.

Applicant's invention as disclosed and claimed in claims 1 and 8 is highly advantageous compared to the prior art for numerous applications such as remote environmental sensing of molecules and long wavelength based communication by providing a high frequency and high speed infrared detector at operating temperatures other than cryogenic, substantially facilitating portability, installation and maintenance.

Applicant respectfully submits that the device defined by the limitations of claims 1 and 8 is highly inventive and not anticipated by Delacourt et al.

Applicant respectfully submits that claims 2 and 3 each depend on a claim that is believed to be allowable and as such are allowable.

Referring to independent method claim 21, Applicant discloses and claims a method for detecting infrared radiation with a quantum well device absent cryogenic cooling based on the apparatus defined by the limitations of claims 1 and 8. Therefore, the above arguments apply here mutatis mutantis.

Applicant respectfully submits that claim 23 depends on a claim that is believed to be allowable and as such is allowable.

Claim Rejections 35 USC § 103

Claims 9-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt et al. (US Patent 5,160,991).

Indeed Delacourt et al. disclose a QWIP, actually even earlier patents – Bethea et al. US Patents 4,894,526 and 5,023,685 – cited in the present application as prior arts teach QWIPs as well. All these QWIPs have in common that they are only operable in the cryogenic temperature range. In column 1 lines 16–20 Delacourt et al. teach that there are two types of detectors known: pyroelectrical detectors which can work at ambient temperatures but are slow and detectors with absorption by a semiconducting material. For one of skill in the art this teaching immediately implies the known fact that detectors with absorption by a semiconducting material are fast but cannot work at ambient temperatures, or to be more specific, need cryogenic cooling. With respect to the teaching by Delacourt et al. in column 4 lines 40-44 ", as cited by the examiner, Delacourt et al. teach that for a QWIP to operate at room temperature the potential barrier should to be greater than kT=26meV. This teaching by Delacourt et al. is wrong. Assuming this teaching to be correct, it would be possible to operate most QWIPs at high temperature, since most QWIPs meet the above limitation specified by Delacourt et al. for high temperature operation. As is evident to one of skill in the art, this is not the case. Further, Delacourt et al. do not address any of the problems - such as dark current - present when operating a QWIP at ambient temperature. Moreover, Delacourt et al. teach that the aim of the

invention is to propose "a detector made of semiconducting materials which can be manufactured by simpler manufacturing techniques and enables the integration of the optical guides and a detector on one and the same substrate", column 1 lines 41-45, but are silent about operating the device at room temperature. Using the teachings of Delacourt et al. it is not obvious to one of skill in the art to make the present invention as defined by the limitations of claims 9-11.

Therefore, Applicant respectfully submits that the invention as defined by the limitations of claims 9-11 is not obvious in view of the teachings of Delacourt et al.

Claims 4-6, 19, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt et al. (US Patent 5,160,991) in view of Liu (Semiconductor and Semimetals, Vol. 62, pp. 129-196, 1999).

Applicant respectfully submits that claims 4-6, 19, and 20 each depend on a claim that is believed to be allowable and as such are allowable.

Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt et al. (US Patent 5,160,991) in view of Liu (Semiconductor and Semimetals, Vol. 62, pp. 129-196, 1999) as applied to claim 6 above, and further in view of Sato et al. (US Patent 5,077,593).

Applicant respectfully submits that claim 7 depends on a claim that is believed to be allowable and as such is allowable.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt et al. (US Patent 5,160,991) in view of Sato et al. (US Patent 5,077,593).

Applicant respectfully submits that claim 12 depends on a claim that is believed to be allowable and as such is allowable.

Claims 13-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt et al. (US Patent 5,160,991) in view of Sato et al. (US Patent 5,077,593) as applied to claim 12 above, and further in view of Liu (Semiconductor and Semimetals, Vol. 62, pp. 129-196, 1999).

Applicant respectfully submits that claims 13-17 each depend on a claim that is believed to be allowable and as such are allowable.

Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt et al. (US Patent 5,160,991) in view of Sato et al. (US Patent 5,077,593) and Liu (Semiconductor and Semimetals, Vol. 62, pp. 129-196, 1999) as applied to claim 17 above, and further in view of Wen et al. (US Patent 5,352,904) and Brouns (US Patent 5,773,831).

Applicant respectfully submits that claim 18 depends on a claim that is believed to be allowable and as such is allowable.

Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt et al. (US Patent 5,160,991) in view of Choi (US Patent 5,384,469).

Applicant respectfully submits that claim 22 depends on a claim that is believed to be allowable and as such is allowable.

Applicant looks forward to favourable reconsideration of the present application.

Please charge any additional fees required or credit any overpayment to Deposit Account No: 50-1142.

Respectfully submitted,

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